PERFORMANCE OF THE FLOW MIXING TECHNOLOGY IN ASPHALT CONCRETE AND THE ASPHALT RUBBER PROJECT IN SWEDEN

Mats Wendel
National Coordinator, Road Surfaces
Where is Sweden?

Champaign, IL
Challenges for Sweden
Yearly increase of heavy traffic

2010, 86% of all conveyance of goods used vehicles with a maximum gross weight >55 metric tonnes

Source: trafikanalys mfl.
www.trafa.se
SWEDEN: Paving market, annually:

- Short paving season, between May-October
- STA end user of 40 - 60 % of the total market
- STA uses about 10 -15 million m² of Chip Seal
- STA uses about 1 million tons of soft asphalt mixes low traffic roads (Pen > 800)
- High performing binders approx. 3-5 % of total HMA used (increasing)
- Performance based contracts (approx 15%, 2011)
- Contractor have full responsibility.
- Warranty: a minimum 5 years (all contracts).
PERFORMANCE OF THE FLOW MIXING TECHNOLOGY IN ASPHALT CONCRETE

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Aknowledgements

KGO Mixing AB, Finja, Sweden

Swedish National Road and Transport Research Institute
What is the Flow Mixing Technology*?

- A technology to produce asphalt concrete mixes with same or better quality without use of extra additives.
- Through a controlled way of production, reduce valuable sources of raw material, save energy, and give long lasting products.

* The Flow Mixing Technology is also called the KGO-III method, which is patented technology by Karl Gunnar Ohlson, Sweden
Flow mixing method*, principles of mixing

1) Course fraction (>1/8”)

2) Binder

3) Filler (i.e. passing #200 sieve)

4) Fine fraction (#200-1/8”)

*Mats Wendel, Swedish Transport Administration

* According to KGO-III method
Normal mixing procedure

In the video, material is used to illustrate the method. All repeating has same amounts of material (water, filler (<#200 sieve) and sand (<No. 40 i.e. 1/12“))
Flow mixing procedure

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Comparison: Normal vs Flow mixing procedure

Under same conditions!
Flow mixing method*, principles of mixing

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* According to KGO-III method
The pavement has a characteristic glow, which indicates thick film coating.
SMA test section U537
7000 AADT, 10% heavy trucks
Positive effects due to observations and testing

- Production temperature can (and must) be lowered and not exceed 325 F – compactability not effected. (No smoke!)
- In Swedish (bitumen rich) top layers, the binder content (%AC), has to be decreased by 0.5%-units (equals approx 8% less bitumen).
- Better homogeneity (!) and the asphalt mix is more sticky and have visibly less segregation.
New test method: TOD – verifies the production

- TOD is a test method to verify that the production works.
- Both lab produced and drilled cores can be tested.
- This is the key to ensure quality.

The TOD test provide a measure of viscous deformation in the specimens.
Ocular comparison (the effect)

Base Layer (1")  Flow mixed Base Layer (1")
Performance of tested Asphalt Concrete
Mix types: Base layer, Binder layer, SMA, Dens graded, Open graded, Thin Asphalt Layers
Binder used: pen. 50/70, 70/100, 100/150, 160/220, PMB, PMA, RAP

- Friction
- Homogenity
- Compactability
- Deformation
- Water sensitivity
- Wear – the Nordic Abrasion test
- Rut depth

- Stiffness
Follow up: KGO-test sections after 3 years of traffic "winter conditioning" - freze/thaw and saltwater
Rut depth development

Results from surface measurements

- Rut after first winter
- Rut depth 2006
- Yearly increasing by

<table>
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<th>Scenario</th>
<th>mm</th>
<th>mm</th>
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Rut depth development over time.
Environmental effects

>600,000 metric tons produced so far in Sweden since 1999

+ Lower temperature
+ Less bitumen
= better quality and better for our environment

There are several reports published, but unfortunately most are in Swedish...

Link: www.vti.se/publications
Pictures from roads produced with the KGO-III method

Note. From 2008, the KGO-III method is allowed on “State roads” according to STA spec.
Flow Mixing Method

Main concerns

• So far, only applied in batch plants
• Old asphalt plants may have a reduced production rate.
• The dissemination of Know-How
• The lab procedure is difficult to perform
• Adjustments, such as gradation and AC-content, may be “out of spec.”
• “Not invented here” – effect and reluctance to try
Flow Mixing Method

Main advantages

• Less segregation
• Enhanced deformation stability
• It’s a “no tender zone” mix
• Known method, years of good performance
• Several positive environmental effects:
  – Energy efficiency (and CO₂)
  – Natural resources
  – Extended technical lifetime
KGO-III surface, paved in 2004, picture from summer 2010.
Mats Wendel, EUR ING
Deputy Head of National Maintenance, Road and Railway

“Everybody arrives smoothly - the green and safe way”
Map

Facts: Hot-mix Asphalt production

<table>
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<tr>
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<th>Million tonnes</th>
<th>No asphalt plants (mobile)</th>
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</thead>
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<tr>
<td>Sweden</td>
<td>8</td>
<td>~100 (12%)</td>
</tr>
<tr>
<td>Europe</td>
<td>310</td>
<td>~4800 (15%)</td>
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<tr>
<td>USA</td>
<td>327</td>
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Source: www.eapa.org, key figures 2010
Challenges for Sweden
Yearly increase of heavy traffic

Billions of metric tonnes kilometres

Conveyance of goods, road
Allowed maximum gross weight

2010, 86% of all conveyance of goods used vechicles with a maximum gross weight >55 metric tonnes

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Asphalt Rubber – a new concept for road pavements in Sweden

• “A three year (2007 – 2009) research and development project where the STA is the main responsible part “

• 2010 – ongoing
  – continuous study of produced test sections
  – continued implementation

Focus: Implementation of already existing technology

Tires with steel studs - an extra challenge for AR
Objectives

• Reduced annual cost by increased technical life time (LCC)

• Environmental advantages
  - Reduction of noise (open concept)
  - Reduction of particle emission
  - Less wear from studded tires?

• Increased traffic safety
  - Better skid resistance
  - Open concept less water curtains
    - splash and spray
The Good Stuff...
History in brief (highlights)


2007: Lots of environmental (green) studies, the rent of binder-blender unit and first test sections.

2008: More test sections, training and a failure with one low noise section.

2009: Swedish specification, test sections on high volume roads.

2010: International conference, the project ended successfully.
History in brief (highlights)

2010: Decision to start a new project (2G), more low noise sections and follow up work.

2011: AR in really cold climate (dens graded AR), thin layer with AR and encounter capacity problems.


2013: Produce test sections with AR-WMA, more 50/50 bids and encouraged contractors.

2014: Established product, put on market.
Some locations for the AR test sections

Close to city:
1. Malmö area
2. Norrköping
3. Gothenburg
4. Jönköping
5. Stockholm
6. Storuman
7. Uppsala

Several test sections at most places.
Challenges we needed to overcome

• Environmental restrictions (Swedish Chemicals Agency)

• Technical possibilities for production
  - Equipment availability (CE marking)
  - The hook-up to Hot-Mix asphalt plants
  - Contractors for paving

• Crumb Rubber supply

• Mix design and laboratory work

• Workers surrounding (i.e. fumes and smell)
Performance testing

- ASU Arizona State University Phoenix
- VTI Swedish Transport and Road Research laboratory Linkoping
- Contractors laboratories
  - Testing mostly according Swedish and European standards

Results are promising! Reality will prove this, and test sections are looking good.

Find out more by visiting our website: www.trafikverket.se/gummiasfalt
Environment related studies

- Workers exposure
  - PAH, far below limiting values
  - Weather conditions have influence on air quality for workers (Air temperature, Wind)

- AR binder increased leaching
  - PAH & Cresols found, but low according to limit
  - Benzothiazole – no acute toxic effect

- Particle emissions
  - AR pavement gave lower emissions than reference

*Note: A new workers safety study has started at the University of Lund.*
AR production in Sweden 2007-2012

- > 110,000 ton of Mix
- > 100 km of test sections
- > 25 Different Projects
- Used around 2,000 ton of Rubber granules (0-1 mm)
What have we achieved with our AR project, so far

1) We can produce Asphalt Rubber with, as expected, good quality!

2) We have shown that environmental issues (leakage, emissions) can be managed. In a broader view there is no negative impact to the surroundings – benefits exists!

3) The workers health can be managed; especially with sharing information and a maximum manufacturing temperature (not to be exceeded).

4) We have a technical specification for AR - GAP graded pavements.

5) Asphalt Rubber is definitely a pavement concept for Swedish roads.
A word of advise,
- a successful project can be achieved if;

• You do your homework properly (investigate, get know-how)
• You make a good plan for the project and get the money
• Use skilled personnel
• You need champions
• Manage your risks – and see the opportunities!
• Share your experience!
Thank you!
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